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McOwat, Kelsey; Stanley-Wall, Nicola R

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Tips & Tools

Biofilm Building: A Simple Board Game to Reinforce Knowledge of Biofilm Formation †

Kelsey McOwat and Nicola R. Stanley-Wall*
Division of Molecular Microbiology, School of Life Sciences, University of Dundee, Dundee, DD1 5EH, UK

INTRODUCTION

Bacterial biofilms can form on a variety of surfaces, and while these collections of bacteria can have advantageous properties, they can also cause hard-to-treat, chronic infections in, for example, cystic fibrosis patients, those on implanted medical devices, or those with severe burns and other wounds (1). Biofilm formation begins with the adhesion of pioneer planktonic bacteria onto a surface (2). Once irreversibly attached, the bacteria begin to produce an extracellular matrix containing components such as polysaccharides, extracellular DNA, and fibrous proteins (3). As the biofilm begins to expand and mature, it can start to exhibit antibiotic tolerance, contributing to the ineffectiveness of treatment regimens in clinical or veterinary settings (4).

We have previously developed an interactive activity called "Blast-a-Biofilm" (7), based around embedding model bacteria in an extracellular matrix, simulated by hair gel, and designed to reveal the fundamental properties of biofilms (Appendix 1). The board game presented here is aimed at young learners (aged 8 to 12) with little to no knowledge of bacteria and biofilms. It requires easily obtainable materials and is suitable as an educational resource in classroom teaching or in community settings. It is played by teams of participants who work to answer questions that allow them to collect the raw materials required for "biofilm" construction that are used in the Blast-a-Biofilm activity. Thus the new educational board game directly interfaces with the Blast-a-Biofilm activity (5). The inclusion of the board game in classroom activities was designed to extend the time available for discussion, thus enhancing the opportunity for learning though increased interactions between the scientist and child.

*Corresponding author. Mailing address: Division of Molecular Microbiology, School of Life Sciences, University of Dundee, Dundee, DD1 5EH UK. Phone: +44(0)1382 385136. Fax: +44(0)1382 388216. E-mail: n.r.stanleywall@dundee.ac.uk
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PROCEDURE

Materials

The materials listed are required for 1 team of up to 4 people working together to complete the game. You will also need the materials needed for the Blast-a-Biofilm activity (see (5) or Appendix 1 for an abbreviated set of instructions).

- Colored modeling clay
- 1 printed and laminated game board (see Appendix 2)
- 14 printed and laminated question cards (see Appendix 3(i) (ii))
- 12 printed and laminated action cards (see Appendix 3(iii) (iv))
- 1 printed and laminated component checklist (see Appendix 3(v))
- 1 die
- 1 whiteboard marker
- 3 different colors of glitter

Safety issues

Supervision is required at all times as there is a small risk of participants ingesting the materials required for the activities. Moreover the Blast-a-Biofilm element requires safety glasses to prevent risk of eye injury.

Preparation

Before playing the game, it is necessary for the educators to have basic knowledge of biofilm formation. Example information has been provided in Appendix 4, with more complete background material available elsewhere, e.g., Marlow *et al.* (5). To start the activity, the basics of biofilm formation should be conveyed to the young learners during a demonstration of the Blast-a-Biofilm activity, revealing how the self-produced matrix protects the bacteria from sheer stress and against "antibiotics" (5) (Fig. S1). Next, reinforce the knowledge of biofilm formation using the board game (Fig. 1): assign the children to teams and ask them to generate a team bacterium using modeling clay for use as a

"counter." Then, provide each team with a checklist for the following items: 3 scoops of biofilm matrix, 10 bacteria, 1 scoop of extracellular DNA, 1 scoop of carbohydrate, and 1 scoop of protein. This is the enhanced set of components required for the Blast-a-Biofilm activity, where the nature of the molecules in the biofilm matrix are specified; see (5).

Playing the board game

Beginning at "Start," the counter is moved around the board according to the roll of the die (Fig. 1). When players land on "bacteria" spaces, the team makes note of it on their checklist, so that they ensure they collect 10 model bacteria. When players land on "question mark" spaces, they must answer the question on a question card from the top of the question card deck. Members of the team take turns to be the question master, as the answer to each question has been printed at the bottom of each card (see Appendix 3(i)). If the question is answered correctly, the team wins an "action card" from the top of the action card deck. These action cards will either give instructions regarding game play or will provide items that are needed from the checklist. The items include biofilm matrix (simulated by hair gel); or the specific subcomponents of the matrix—extracellular DNA, carbohydrates, and proteins. These three elements are represented by glitter of different colors. The teams race against each other to be the first to obtain a completed checklist. Game play concludes for all teams once one team has collected all of the items. Continuing to work in their teams, the children should produce their own "biofilm" using the same method as the Blast-a-Biofilm demonstration (5), incorporating the materials they have collected during the board game (e.g., the model microbes, the hair gel, and the glitter). Essentially, they simply measure out and place the collected materials on a surface (Fig. S1). Once the biofilm is constructed, it becomes evident when they try to "blast" it that inclusion of all of the "biofilm matrix" components generates a powerfully robust structure that resists the water spray (antibiotic) exposure.

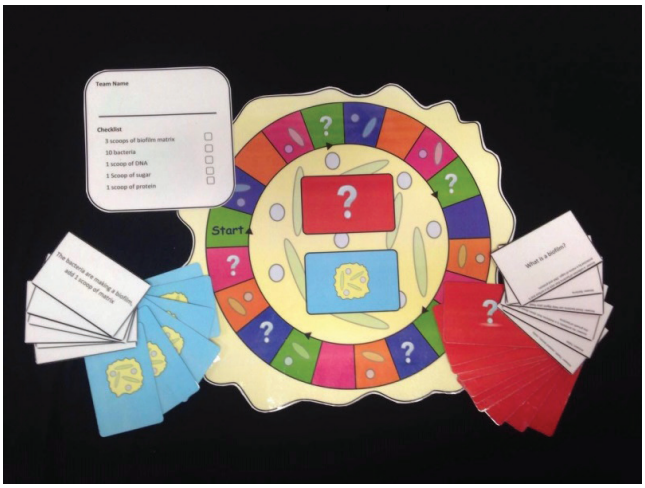

FIGURE 1. The biofilm board game and associated game cards.

CONCLUSION

We have found that inclusion of this board game into the Blast-a-Biofilm resource provides a safe, interactive, entertaining, and educational tool. Classroom feedback from participants, along with quizzes to assess learning, revealed increased knowledge regarding bacteria, biofilms, and how the biofilm matrix forms after participation. Simple surveys showed that the children successfully learnt new vocabulary and facts regarding biofilms. The children also showed interest and enjoyment in science alongside a wish to learn more about biofilms. This board game can also be used to educate teachers and parents or to convey important public health messages, including the importance of listening to your medical practitioner regarding matters of antibiotics and completing a course of antibiotics as instructed.

SUPPLEMENTAL MATERIALS

Appendix 1: Brief instructions for Blast a Biofilm
Appendix 2: Printable board game
Appendix 3: Question cards, action cards, and checklist
Appendix 4: Basic background information

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